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Operation of the Psychrometric Program PSYCHRO

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Summary

This article explains the operation of a menu driven program, PSYCHRO, that simulates the psychrometric chart. The program was written in BASIC for an Apple IIe microcomputer, however, a program listing is included to permit translation to another version of BASIC. Listings of menus and options are given; example results are presented. PSYCHRO permits a choice of English or metric units; atmospheric pressure must be specified, then six combinations of state-variable pairs are accepted as input. The program incorporates a system of error traps; where solutions are not possible, error messages are printed. A table of psychrometric variables are displayed on the computer screen and may be printed.

Operation of the Psychrometric Program PSYCHRO[1]

R. D. Brazee and R. D. Fox[2]

Water vapor makes up less than 2% by weight of the atmosphere, but this small portion has major effects on weather owing to its latent energy. The amount of water vapor in moist air can be expressed as relative humidity, wet-bulb temperature, dew-point temperature, absolute humidity, or in other ways dependent on needs. These parameters, along with atmospheric pressure and air temperature, define the psychrometric state of a moist atmosphere. The parameters are related, and if atmospheric pressure and two other parameters are known, all psychrometric state parameters can be calculated.

Psychrometric charts are widely used to determine the state of a moist atmosphere. These charts can be simulated with a microcomputer to permit convenient calculation of all psychrometric parameters required to specify psychrometric state. This article explains how to use the PSYCHRO program to calculate psychrometric parameters.

The Program

PSYCHRO is a menu-driven BASIC program which uses psychrometric regression and equations developed by Brooker (3) [also published in ASAE Standards (1)] to calculate psychrometric states. Brazee and Fox (1986) discussed psychrometric calculations and their use in orchard microclimate studies.

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[1]This article is a contribution of the Laboratory for Pest Control Application Technology, Ohio State University/Ohio Agricultural Research and Development Center, Wooster OH.

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The PSYCHRO program calculates a set of psychrometric state variables, given atmospheric pressure and two of the state variables as input. The program is available in either DOS 3.3 or PRODOS versions for Apple II[3] computers. A listing of PSYCHRO is given in Appendix B.

Barometric Pressure

Atmospheric pressure (PA) does not have a major effect on values of the set of psychrometric variables, but it is important for precise work and is required for the program to operate. Barometric pressures given in broadcast weather reports are always corrected to sea level. The pressure can be corrected for local elevation with the formula

$$PA(\text{local}) = PA(\text{sea level}) - .001\ E$$

where PA is atmospheric pressure in in Hg and E is elevation in ft. For example, if the local elevation is 900 ft above sea level and a weather broadcast reports a barometric pressure of 30.10 in Hg, then local atmospheric pressure is

$$PA(\text{local}) = 30.10 - .001 \times 900 = \underline{29.20 \text{ in Hg.}}$$

At startup, PSYCHRO automatically selects the standard pressure of 29.92 in Hg, or equivalent in other units. However, the PRESSURE UNIT MENU provides an option for entering non-standard local pressure.

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[3] Reference to a proprietary product or company is for specific information only and does not imply approval or recommendation of the product by the U.S. Department of Agriculture or the Ohio State University to the exclusion of others that may be suitable.

Operation

System operation is best outlined with a sample problem.

Upon start-up, the Main Menu appears:

MAIN MENU
CR - Begin calculation
1 - Display system guide on screen
2 - List system guide on printer
3 - Exit
Enter number:

CR refers to the RETURN key; the system guide is a brief "help" section, printed in Appendix A of this report; and Exit is a return to BASIC.

Selection of [CR]; (In this report, the brackets [ ] enclose specific keyboard entries) is followed by the message:

Loading operating database.

After a few seconds, the Unit Menu is displayed:

PSYCHROMETRIC SYSTEM: UNIT MENU
CR - Use current units and ambient pressure
1 - Metric units (SI)
2 - English units (EU)
3 - Exit
Enter number:

If a non-allowable response is entered for any menu, the Menu simply reappears. At start-up, no units are specified, in which case a [CR] will not satisfy PSYCHRO; and the user must select 1, 2, or 3. Each number or letter entered must be followed by a [CR]. For this example, we enter [2] and the Pressure Unit Menu is displayed:

PA = 14.676 psi
PRESSURE UNIT MENU (EU)
CR - Jump to calculations
1 - psi
2 - in Hg
3 - Other units
Enter number:

An entry [CR] will maintain the standard atmospheric pressure and units, 14.676 psi. The units specified by name (psi, in Hg, in English Units) have standard conversion factors resident within the system. If [3] is selected, "Other Units", a conversion factor from psi to the new units must be entered. If we were to choose ft of water for our units, the conversion factor would be calculated as:

$$PA\ (ft\ H\ 0) = FACTOR * PA\ (psi),$$

with $$FACTOR = \frac{PA\ (ft\ H\ 0)}{PA\ (psi)} = \frac{33.77}{14.676}\ (standard\ values),$$

and Factor = 2.30.

The value of 2.3 for FACTOR would be entered when the program asked for conversion factor from psi to ft of water. We now continue our example by entering [2], and the screen display becomes:

Non-Standard PA? (Y or CR)

We select [Y] (upper-case Y), and get the screen display:

PA =

For this example, we enter [29.20], and should get:

PA = 29.2 in Hg
New PA (Y or CR)

If the display is correct, the [CR] is selected and the Problem Statement Menu is displayed:

PROBLEM STATEMENT MENU

Select a variable pair
1 - TATW
2 - TATD
3 - TARH
4 - TWRH
5 - TAPV
6 - TAAH
Enter number:

The input variables, to be entered in pairs, are defined as:

TA - air temperature (°F);
TW - Wet-bulb temperature (°F);
TD - Dew-point temperature (°F);
RH - Relative humidity (.02 - .99);
PV - Water vapor pressure (in. Hg); and
AH - Absolute humidity (lbs water/lb. dry air).

The units are as shown since English Units were chosen. For improper input data where a solution is not possible, PSYCHRO has programmed error traps, that display an error message. For example, in some cases, it may be difficult to calculate water vapor quantities near zero and near saturation. Some of the error messages displayed are:

Improper division; Improper logarithmic argument;

Imaginary square root; Computed pressure, P>PA;

Overflow; and problem out of range.

Each statement is followed by the name of the subroutine where the error occurred, and a list of values for internal parameters is displayed. This information normally is used only for error detection when adapting the program to a different computer. Usually the user simply enters corrected input values.

To return to the example, enter [1] for TATW, and the display is:

Enter value for TA

Enter [80], for 80°F, and then:

Enter value for TW

Enter [60], and the display becomes:

Analysis in Progress

Following the CRT display of the analysis results, depress spacebar to continue.

After 10-30 seconds of computing, depending on the problem entered, the results will be displayed on the screen. Results for the sample problem are shown in Figure 1.

Following inspection of the results, the user depresses the spacebar, and Data Display Menu appears:

DATA DISPLAY MENU

CR - Enter new data
1 - Redisplay results
2 - Print results
3 - Change units
4 - Change ambient pressure
5 - Return to MAIN MENU
6 - Exit
Enter number:

Each option is obvious; if 3, 4, or 5 is selected, the system returns to displays or operations previously used for the example. Option 5 essentially restarts the program from the beginning; all values entered are replaced with start-up values.

If other options were selected from program menus, procedures will be similar to those given. Metric units are different, i.e., on the PRESSURE UNIT MENU, but your responses would be apparent.

Results

Example results from psychrometric calculations are shown in Figures 2 and 3. Figure 2 calculations were made using three different metric units for atmospheric pressure and demonstrate a range of psychrometric conditions. Results of three psychrometric calculations using English units are shown in Figure 3. The first two examples compare equal dry bulb temperature and relative humidity but with a change in atmospheric pressure from 29.92 to 28.92 in Hg.

These example calculations demonstrate values of psychrometric state variables under a range of meteorological conditions.

References

(1) _____. ASAE Standards, 1984. American Society of Agric. Engineers, 2450 Niles Road, St. Joseph, MI 49085-9659.

(2) Brazee, R. D., and R. D. Fox. 1986. Measurng atmospheric water vapor. OARDC/OSU Research Circular 290, Fruit Crops 1986: A Summary of Research, pp. 24-25.

(3) Brooker, D. B. 1967. Mathematical model of the psychrometric chart. Trans. of the ASAE 10(4):558-560,563.

```
PSYCHROMETRIC STATF                          Date: 05/19/86 Time: 11:43:59
  Total  pressure: 29.2 in Hg

                      Temperature          Saturation vapor pressure
                        (F Deg)                    (in Hg)
Dry-bulb.........     80.........              1.03
Wet-bulb.........     60.........              .522
Dew-point........     46.........              .312

Relative humidity....      .302
Absolute humidity....      6.71999999E-03 Lb water/lb dry air
Specific humidity....      6.67999999E-03 Lb water/lb air
Specific volume......      14.1 cu ft/lb dry air
Enthalpy of mixture..      26.6 BTU/lb dry air
```

Figure 1. Example results from PSYCHRO program.

PSYCHROMETRIC STATE Date: 04/17/87 Time: 16:41:27
Total pressure: 101300 Pascal

	Temperature (C Deg)	Saturation vapor pressure (Pascal)
Dry-bulb.....	5.....	873
Wet-bulb.....	1.07.....	661
Dew-point.....	-5.....	404

Relative humidity....	.463
Absolute humidity....	2.49E-03 kg water/kg dry air
Specific humidity....	2.48E-03 kg water/kg air
Specific volume.....	.791 cu m/kg dry air
Enthalpy of mixture..	11293 J/kg dry air

PSYCHROMETRIC STATE Date: 04/20/87 Time: 07:33:41
Total pressure: 760 mm Hg

	Temperature (C Deg)	Saturation vapor pressure (mm Hg)
Dry-bulb.....	35.....	42.2
Wet-bulb.....	14.3.....	12.2
Dew-point.....	-9.18.....	2.11

Relative humidity....	.05
Absolute humidity....	1.73E-03 kg water/kg dry air
Specific humidity....	1.73E-03 kg water/kg air
Specific volume.....	.875 cu m/kg dry air
Enthalpy of mixture..	39700 J/kg dry air

PSYCHROMETRIC STATE Date: 04/20/87 Time: 07:58:17
Total pressure: 1013 millibar

	Temperature (C Deg)	Saturation vapor pressure (millibar)
Dry-bulb.....	35.....	56.2
Wet-bulb.....	34.8.....	55.8
Dew-point.....	34.8.....	55.7

Relative humidity....	.99
Absolute humidity....	.0361 kg water/kg dry air
Specific humidity....	.0349 kg water/kg air
Specific volume.....	.924 cu m/kg dry air
Enthalpy of mixture..	128000 J/kg dry air

Figure 2. Three examples of results of psychrometric calculations using metric units.

PSYCHROMETRIC STATE Date: 04/17/87 Time: 16:55:07

Total pressure: 28.9 in Hg

	Temperature (F Deg)	Saturation vapor pressure (in Hg)
Dry-bulb.....	80.....	1.03
Wet-bulb.....	66.5.....	.656
Dew-point.....	59.7.....	.516

Relative humidity....	.5
Absolute humidity....	.0113 Lb water/lb dry air
Specific humidity....	.0112 Lb water/lb air
Specific volume.....	14.3 cu ft/lb dry air
Enthalpy of mixture..	31.6 BTU/lb dry air

PSYCHROMETRIC STATE Date: 04/17/87 Time: 16:54:10

Total pressure: 29.9 in Hg

	Temperature (F Deg)	Saturation vapor pressure (in Hg)
Dry-bulb.....	80.....	1.03
Wet-bulb.....	66.7.....	.659
Dew-point.....	59.7.....	.516

Relative humidity....	.5
Absolute humidity....	.0109 Lb water/lb dry air
Specific humidity....	.0108 Lb water/lb air
Specific volume.....	13.8 cu ft/lb dry air
Enthalpy of mixture..	31.2 BTU/lb dry air

PSYCHROMETRIC STATE Date: 04/20/87 Time: 07:36:42

Total pressure: 14.7 Psi

	Temperature (F Deg)	Saturation vapor pressure (Psi)
Dry-bulb.....	15.....	.0398
Wet-bulb.....	11.9.....	.0342
Dew-point.....	1.3.....	.0199

Relative humidity....	.5
Absolute humidity....	8.44E-04 Lb water/lb dry air
Specific humidity....	8.44E-04 Lb water/lb air
Specific volume.....	12 cu ft/lb dry air
Enthalpy of mixture..	4.51 BTU/lb dry air

Figure 3. Three examples of results of psychrometric calculations using english units.

APPENDIX A. System Guide from PSYCHRO Program

PSYCHRO SYSTEM GUIDE

The primary psychrometric variables used are:

TA=dry-bulb temperature;
TW=wet-bulb temperature;
TD=dew-point temperature;
PA=total ambient pressure;
PS=saturation vapor pressure;
PW=wet-bulb saturation vapor pressure;
PV=dew-point saturation vapor pressure;
RH=PV/PS=relative humidity;
H=absolute humidity or mixing ratio;
Q=specific humidity=H/(1+H);
VSA=specific volume;
HE=enthalpy of air-water vapor mixture.

NOTES:

The total pressure, PA, can be entered (or standardized) and stored until changed by user command. Pressure units can be chosen as desired but conversion factors must be supplied except for some standard cases. The pressure units for which conversion factors are supplied are: Pascal; cm Hg; mm Hg; millibar; bar; dyne/sq cm; psi; and in Hg. The general unit system can be selected by entering'SI'(International standard...metric) or 'EU' (English units).
The abbreviation 'CR' signifies 'RETURN' wherever the response is appropriate. Six distinct problem classes are allowed: TATW, TATD, TARH, TWRH, TAPV, and TAAH. The symbol combination 'AH' must be used to denote the absolute humidity or mixing ratio, H, in order to avoid confusion in the system.

APPENDIX B: PROGRAM LISTING

```
100  REM  *** PSYCHRO  ***
110  GOTO 180
120  REM    ** STATEMENT 170 IS USED TO AID ESCAPE-EDITING OF APPLESOFT
130  REM    ** BASIC.  EXECUTE 'RUN 170' BEFORE STARTING EDITING WILL
140  REM   ** ELIMINATE SPACES BETWEEN THE END OF ONE LINE AND THE
150  REM   ** BEGINNING OF THE STATEMENT CONTINUATION ON THE NEXT
160  REM   ** LINE.
170  TEXT : PRINT  CHR$ (21): POKE 33,33: HOME : END
180  REM  ***  COPYRIGHT 8-7-81 BY R.D. BRAZEE  ***
190  REM   ** PSYCHRO SYSTEM  **
200  REM      ** WRITTEN IN APPLESOFT BASIC FOR APPLE //e WITH TIME CARD
    IN SLOT 4.
210  REM  **   FOR SYSTEM WITHOUT A CLOCK CARD, DELETE STATEMENTS 310 AN
    D 4830
220  REM     ** CALL -3288: CANCELS ONERR GOTO
230  REM    ** POKE 216,0: USE WITH GO TO IN PLACE OF RESUME
240  REM    ** POKE 1403,XX: TABS HORIZONTALLY XX SPACES FROM LEFT EDGE
    OF SCREEN.
250  REM   ** POKE 36,XX TABS HORIZONTALLY XX SPACES FROM LEFT EDGE, WOR
    KS WITH BOTH SCREEN AND PRINTER.
260  DIM A(9),C(20),TT(5),PT(2),X(2),X$(2),T$(6),V$(6),L$(15)
270  DIM AS(9),AE(9),NS(20),NE(20),LS(5),BS(2),BE(2),LE(5)
280  DIM GU$(39),CL%(7)
290  READ PR$,RD$,IA$
300  HOME : PRINT "Date and time are maintained for PSYCHRO"
310  GOSUB 5630
320  FOR II = 1 TO 50
330  VTAB 12: HTAB 10: PRINT "DATE:"; MID$ (TIME$,3,8)
340  HTAB 10: PRINT "TIME:"; RIGHT$ (TIME$,8): NEXT
350  FOR II = 1 TO 39: READ GU$(II): NEXT
360  HOME : PRINT  TAB( 6);"MAIN MENU": PRINT : PRINT "  CR-Begin calcul
    ations"
370  PRINT "   1-Display system guide on screen": PRINT "   2-List syste
    m guide on printer"
380  PRINT "   3-Exit": INPUT "Enter number: ";A$
390  IF A$ = "" THEN 460
400 II =  VAL (A$): IF II < 1 OR II > 3 THEN 360
410  ON II GOTO 5410,420,5620
420  IF  PEEK (49305) > 100 THEN 440
430  GOTO 5530
440  FOR II = 1 TO 10: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 15: VTAB 1
    5: PRINT PR$;IA$
450  FOR JJ = 1 TO 200: NEXT JJ: NEXT II: GOTO 360
460  TEXT : HOME : HTAB 8: VTAB 12: PRINT "Loading operating database."
470 IW% = 0:ID$ = "": READ M1,M2,A1,B1,C1,D1,E1,F1,G1,R1
480  READ A2,B2,C2,D2,E2,F2,G2,R2
490  FOR II = 1 TO 9: READ AS(II),AE(II): NEXT
```

```
500  FOR II = 1 TO 20: READ NS(II),NE(II): NEXT
510  FOR II = 1 TO 5: READ LS(II),LE(II): NEXT
520  FOR II = 1 TO 2: READ BS(II),BE(II): NEXT
530  FOR II = 1 TO 6: READ T$(II): NEXT
540  FOR II = 1 TO 6: READ V$(II): NEXT
550  FOR II = 1 TO 15: READ L$(II): NEXT
560  READ DA$,WA$,D$
570  READ CN$,MM$,BR$,MB$,DY$,IN$,HG$: RESTORE : GOTO 2980
580  DATA "PRINTER ","READY","INACTIVE"
590  DATA "PSYCHRO SYSTEM GUIDE"
600  DATA "The primary psychrometric variables used are:"
610  DATA "TA=dry-bulb temperature;"
620  DATA "TW=wet-bulb temperature;"
630  DATA "TD=dew-point temperature;"
640  DATA "PA=total ambient pressure;"
650  DATA "PS=saturation vapor pressure;"
660  DATA "PW=wet-bulb saturation vapor pressure;"
670  DATA "PV=dew-point saturation vapor pressure;"
680  DATA "RH=PV/PS=relative humidity;"
690  DATA   "H=absolute humidity or mixing ratio;"
700  DATA "Q=specific humidity=H/(1+H);"
710  DATA "VSA=specific volume;"
720  DATA "HE=enthalpy  of air-water vapor mixture."
730  DATA "NOTES:"
740  DATA  "The total pressure, PA, can be entered"
750  DATA "(or standardized) and stored until"
760  DATA "changed by user command. Pressure units"
770  DATA  "can be chosen as desired but conversion"
780  DATA "factors must be supplied except for"
790  DATA "some standard cases. The pressure units"
800  DATA "for which conversion factors are"
810  DATA "supplied are: Pascal; cm Hg; mm Hg;"
820  DATA "millibar; bar; dyne/sq cm; psi; and"
830  DATA  "in Hg. The general unit system can be"
840  DATA     "selected by entering'SI'(International"
850  DATA "standard...metric) or 'EU' (English"
860  DATA "units)."
870  DATA "  "
880  DATA  "The abbreviation 'CR' signifies"
890  DATA   "'RETURN' wherever the response is"
900  DATA "appropriate. Six distinct problem"
910  DATA  "classes are allowed: TATW, TATD, TARH,"
920  DATA "TWRH, TAPV, and TAAH. The symbol"
930  DATA "combination 'AH' must be used to denote"
940  DATA   "the absolute humidity or mixing ratio,"
950  DATA  "H, in order to avoid confusion in the"
960  DATA  "system."
970  DATA "  "
980  DATA .15577,.62194
990  DATA -27405.5,97.5413,-.146244,.12558E-3
```

```
1000  DATA -.48502E-7,4.34903,.39381E-2,.221056E+8
1010  DATA -27405.5,54.1896,-.045137,.21532E-4
1020  DATA -.462027E-8,2.41613,.121547E-2,3206.18
1030  DATA 19.5322,35.1579,13.6626,24.5926
1040  DATA     1.17678,2.11821,-.189693,-.341447
1050  DATA  .087453,.157416,-.174053E-1,-.313296E-1
1060  DATA .214768E-2,.386583E-2,-.138343E-3,-.249018E-3
1070  DATA .38E-3,.684016E-5
1080  DATA 31.9602,23.3924,6270.36,11286.6
1090  DATA .46057,.46057,255.38,459.69
1100  DATA .00145,10,.283968E+7,1220.84
1110  DATA 212.564,.05077,.250254E+7,1075.896
1120  DATA 2385.76,.56983,273.16,491.69
1130  DATA .732916E+13,.135467E+7,.15996E+8,.912528
1140  DATA 1006.92,.2405,287,53.35
1150  DATA 1,144,273.16,459.69
1160  DATA 333432,143.35,2030.6,.485
1170  DATA 1875.69,.448,4186.8,1
1180  DATA 255.38,459.69,273.16,491.69,338.72
1190  DATA 609.69,373.16,671.69,533.16,959.69
1200  DATA 620.52,.09,.46884E+7,680
1210  DATA "TATW","TATD","TARH","TWRH","TAPV","TAAH"
1220  DATA  "PV","RH","TA","TD","TW","AH"
1230  DATA  "PSYCHROMETRIC STATE","pressure","Total"
1240  DATA     "vapor"    ,"Temperature","Saturation"
1250  DATA    "bulb","Dry-","Wet-","Dew-point","humidity...."
1260  DATA   "Relative ","Absolute","Specific volume......"
1270  DATA   "Enthalpy of mixture.."
1280  DATA  " dry air"," air","........"
1290  DATA  "cm","mm","bar","millibar","dyne","in","Hg"
1300  IF ID$ = "" THEN SR$ = "": GOTO 1320
1310 R$ = "subroutine"
1320  IF DE% > 8 THEN 1340
1330  ON DE% GOTO 1370,1380,1390,1370,1370,1370,1430,1400
1340  PRINT "DE%";DE%
1350 WE% = DE% - 8: ON WE% GOTO 1410
1360  REM   *MAXIMUM DE% IS 9 FOR THIS VERSION OF PSYCHRO **
1370 EM$ = "Improper division": GOTO 1430
1380 EM$ = "Improper logarithmic argument": GOTO 1430
1390 EM$ = "Imaginary square root": GOTO 1430
1400 EM$ = "Computed pressure, P>PA": GOTO 1430
1410 EM$ = "Overflow": GOTO 1430
1420 EM$ = "Problem out of range.":DE% = 7: GOTO 1300
1430  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: PRINT EM$: PRINT

1440  PRINT SR$;ID$: FOR JJ = 1 TO 200: NEXT JJ: NEXT II
1450 ID$ = "": PRINT : PRINT "Pressures: ABS(";PU$;")"
1460  PRINT "P=";P: PRINT "PS=";PS
1470  PRINT "PW=";PW: PRINT "PV=";PV: PRINT
1480  PRINT "Temperatures: ABS.(";AU$;")..(";TU$;")"
1490  PRINT "TA=";TA;".. ";TA - RK
```

```
1500  PRINT "TW=";TW;".. ";TW - RK: PRINT "TD=";TD;".. ";TD - RK
1510  PRINT "T=";T;".. ";T - RK;" ....SPACEBAR ";
1520  PRINT "to continue."
1530  GET A$: GOTO 3800
1540  REM  * SUBR SATP *
1550 K% = 1: IF T >  = TT(1) AND T <  = TT(2) THEN 1630
1560  IF T >  = TT(2) AND T <  = TT(5) THEN 1670
1570  IF IW% = 0 THEN 1590
1580  GOTO 1600
1590 ID$ = "SATP": GOTO 1420
1600  IF T <  = TT(2) THEN 1620
1610  GOTO 1670
1620  ONERR  GOTO 1640
1630 P =  EXP (C(1) - (C(2) / T) - (C(3) *  LOG (T))): GOTO 1650
1640 DE% = 2: CALL  - 3288: GOTO 1660
1650  POKE 216,0: GOTO 1770
1660 IW% = 0:ID$ = "SATP": POKE 216,0: GOTO 1300
1670  ONERR  GOTO 1690
1680  GOTO 1700
1690 DE% = 9: CALL  - 3288: GOTO 1660
1700 Y = A + T * (B + T * (C + T * (D + T * E)))
1710  ONERR  GOTO 1730
1720  GOTO 1740
1730 DE% = 1: CALL  - 3288: GOTO 1660
1740 Y = Y / ((F * T) - (G * (T * T)))
1750  ONERR  GOTO 1690
1760 P = R *  EXP (Y): POKE 216,0
1770  IF IW% = 0 THEN 1870
1780 EX = (P - PX) / PX:EP =  ABS (EX)
1790  IF EP <  = .00001 THEN 1830
1800  IF K% <  = 50 THEN K% = K% + 1: GOTO 1820
1810  GOTO 1830
1820 T = TB * (1 - ((TB / (C(2) - (C(3) * TB))) * EX)):TB = T: GOTO 1600

1830 IW% = 0:P = PX
1840  IF T >  = TT(1) AND T <  = TT(2) THEN 1870
1850  IF T >  = TT(2) AND T <  = TT(5) THEN 1870
1860  GOTO 1590
1870  IF (P > PA) THEN 1890
1880  GOTO 1900
1890 DE% = 8:ID$ = "SATP": GOTO 1300
1900  IF K% > HK% THEN HK% = K%
1910  RETURN
1920  REM  * SUBR SATT *
1930  IF P >  = PT(1) AND P <  = PT(2) THEN 1970
1940  IF P > PT(2) THEN 1960
1950 IW% = 1:PX = P: GOTO 1970
1960 ID$ = "SATT": GOTO 1420
1970  ONERR  GOTO 2000
1980  GOTO 2010
1990 IW% = 0: POKE 216,0:ID$ = "SATT": GOTO 1300
```

```
2000 DE% = 2: CALL  - 3288: GOTO 1990
2010 T = C(4):Y =  LOG ((C(5)) * P)
2020  ONERR  GOTO 2040
2030  GOTO 2050
2040 DE% = 9: CALL  - 3288: GOTO 1990
2050  FOR II = 2 TO 9:J% = II - 1
2060 T = T + A(II) * (Y ^ J%): NEXT : POKE 216,0
2070  IF IW% = 0 THEN 2090
2080  GOTO 2100
2090 IW% = 1:PX = P:TB = T: GOSUB 1540: GOTO 2110
2100 TB = T: GOSUB 1540
2110 IW% = 0
2120  RETURN
2130  REM  * SUBR WETBL *
2140 M% = 1
2150  IF TW >  = TT(1) AND TW <  = TT(2) THEN 2190
2160  IF TW >  = TT(2) AND TW <  = TT(3) THEN 2200
2170  IF TW >  = TT(3) AND TW <  = TT(5) THEN 2210
2180  GOTO 2330
2190 HGP = C(6) - (C(7) * (TW - C(4))): GOTO 2260
2200 HGP = C(8) - (C(9) * (TW - C(10))): GOTO 2260
2210  ONERR  GOTO 2240
2220  GOTO 2250
2230 IW% = 0: POKE 216,0:ID$ = "WETBL": GOTO 1300
2240 DE% = 3: CALL  - 3288: GOTO 2230
2250 HGP =  SQR (C(11) - (C(12) * (TW ^ 2))): POKE 216,0
2260 DAPW = PW - PA:PQ = PV / PA
2270  ONERR  GOTO 2290
2280  GOTO 2300
2290 DE% = 4: CALL  - 3288: GOTO 2230
2300 BP = ((C(13) * DAPW) * (1 + (M1 * PQ))) / (M2 * HGP): POKE 216,0
2310 DTW = TW - TA:DPW = PW - PV
2320  IF TA >  = TT(1) AND TA <  = TT(5) THEN 2340
2330 ID$ = "WETBL": GOTO 1420
2340  ON ICL% GOTO 2350,2360,2360,2400,2360,2360
2350 PO = PV:PV = PW - (BP * DTW):PV = (PV + PO) / 2: GOTO 2490
2360 TI = TW:PO = PW
2370 TW = TA + (DPW / BP):TW = (TW + TI) / 2:T = TW: GOSUB 1540:PW = (P +
    PO) / 2
2380 EP =  ABS ((PO - PW) / PW):ET =  ABS ((TI - TW) / TW):ER = 0
2390  GOTO 2450
2400 TI = TA:PO = PV
2410 TA = TW - (DPW / BP):TA = (TA + TI) / 2:T = TA: GOSUB 1540:PS = P
2420 PV = ((PS * RH) + PO) / 2:RT = PV / PS
2430 ER =  ABS ((RT - RH) / RH)
2440 EP =  ABS ((PO - PV) / PV):ET =  ABS ((TI - TA) / TA)
2450  IF EP <  = .00001 AND ET <  = .00001 AND ER <  = .00001 THEN 2500
2460  IF M% <  = 50 THEN 2480
2470  GOTO 2500
2480 M% = M% + 1: GOTO 2150
2490 EP =  ABS ((PO - PV) / PV):ET = 0:ER = 0: GOTO 2450
```

```
2500  IF M% > HM% THEN HM% = M%
2510  RETURN
2520  REM  * SUBR ABSH *
2530  IF TA >  = TT(1) AND TA <  = TT(5) THEN 2550
2540  GOTO 2570
2550  IF ICL% = 6 THEN 2580
2560  IF (PV < PA) THEN 2600
2570 ID$ = "ABSH": GOTO 1420
2580 PV = (H * PA) / (H + M2): IF (PV < PA) THEN 2610
2590  GOTO 2570
2600 H = (M2 * PV) / (PA - PV)
2610  RETURN
2620  REM  * SUBR SPVOL*
2630  IF TA >  = TT(1) AND TA <  = TT(5) THEN 2650
2640  GOTO 2660
2650  IF PV <  = (PA) THEN 2670
2660 ID$ = "SPVOL": GOTO 1420
2670 VSA = (C(14) * TA) / (C(15) * (PA - PV))
2680  RETURN
2690  REM  * SUBR ETLPY *
2700  IF TD >  = TT(1) AND TD <  = TT(2) THEN 2730
2710  IF TD >  = TT(2) AND TD <  = TT(4) THEN 2760
2720 ID$ = "ETLPY": GOTO 1420
2730 HDPG = C(6) - (C(7) * (TD - C(4)))
2740 HE = (C(13) * (TA - C(16))) - (H * (C(17) + (C(18) * (C(10) - TD)))
   )
2750 HE = HE + (HDPG * H) + (C(19) * H * (TA - TD)): GOTO 2850
2760  IF TD <  = TT(3) THEN 2780
2770  GOTO 2790
2780 HDPG = C(8) - (C(9) * (TD - C(10))): GOTO 2830
2790  ONERR  GOTO 2810:HDPG =  SQR (C(11) - (C(12) * (TD ^ 2)))
2800  POKE 216,0: GOTO 2830
2810 DE% = 3: CALL  - 3288: GOTO 2820
2820  POKE 216,0:ID$ = "ETLPY": GOTO 1300
2830 HE = (C(13) * (TA - C(16))) + (C(20) * H * (TD - C(10)))
2840 HE = HE + (HDPG * H) + (C(19) * H * (TA - TD))
2850  RETURN
2860  REM  * SUBR RELH *
2870  ON ICL% GOTO 2880,2880,2930,2940,2880,2880
2880  ONERR  GOTO 2910
2890  GOTO 2920
2900  POKE 216,0:ID$ = "RELH": GOTO 1300
2910 DE% = 4: CALL  - 3288: GOTO 2900
2920 RH = PV / PS: POKE 216,0: GOTO 2950
2930 PV = RH * PS: GOTO 2950
2940  ONERR  GOTO 2910:PS = PV / RH: POKE 216,0
2950  RETURN
2960  REM  * SUBR SPHUM *
2970 Q = H / (1 + H): RETURN
2980 UO$ = "":PA = 0:PU$ = ""
2990  HOME : PRINT "  PSYCHROMETRIC SYSTEM: UNIT MENU": PRINT
```

```
3000  PRINT  TAB( 3);"CR-Use current units and ambient pressure"
3010  PRINT  TAB( 4);"1-Metric units (SI)": PRINT  TAB( 4);"2-English un
    its (EU)"
3020  PRINT  TAB( 4);"3-Exit": INPUT "Enter number: ";A$
3030  IF A$ = "" THEN 3080
3040  IF A$ = "1" THEN A$ = "SI": GOTO 3080
3050  IF A$ = "2" THEN A$ = "EU": GOTO 3080
3060  IF A$ = "3" THEN 5620
3070  GOTO 2990
3080  IF A$ = "SI" OR A$ = "EU" OR A$ = "" THEN 3100
3090  GOTO 2790
3100  IF UN$ <  > "SI" AND UN$ <  > "EU" AND A$ = "" THEN 2990
3110  IF A$ = "" AND UO$ <  > "" THEN 3180
3120 UN$ = A$: IF UN$ = UO$ THEN 3180
3130 UO$ = UN$: IF PU$ <  > "" AND PU$ = UN$ THEN 3180
3140  IF UN$ = "SI" THEN 3160
3150  IF UN$ = "EU" THEN 3170
3160 PA = 101324:PU$ = "Pascal":PCF = 1: GOTO 3180
3170 PA = 14.696:PU$ = "Psi":PCF = 1
3180  PRINT : PRINT "PA=";PA;" ";PU$: PRINT
3190  IF UN$ = "SI" THEN 3230
3200  IF UN$ = "EU" THEN 3300
3210  IF A$ = "" THEN 3610
3220  GOTO 2980
3230  PRINT  TAB( 4);"PRESSURE UNIT MENU (SI)": PRINT
3240  PRINT  TAB( 5);"CR-Jump to calculations": PRINT  TAB( 6);"1-Pascal
    s"
3250  PRINT  TAB( 6);"2-cm Hg": PRINT  TAB( 6);"3-mm Hg": PRINT  TAB( 6)
    ;"4-millibar"
3260  PRINT  TAB( 6);"5-bar": PRINT  TAB( 6);"6-dynes/sq cm": PRINT  TAB(
    6);"7-Other units"
3270  INPUT "Enter number: ";A$: IF A$ = "" THEN 3610
3280 II =  VAL (A$): IF II < 1 OR II > 7 GOTO 3230
3290  ON II GOTO 3380,3480,3490,3500,3510,3520,3540
3300  PRINT  TAB( 4);"PRESSURE UNIT MENU (EU)": PRINT
3310  PRINT  TAB( 5);"CR-Jump to calculations": PRINT  TAB( 6);"1-Psi"
3320  PRINT  TAB( 6);"2-in Hg": PRINT  TAB( 6);"3-Other units"
3330  INPUT "Enter number: ";A$: IF A$ = "" THEN 3610
3340 II =  VAL (A$): IF II < 1 OR II > 3 GOTO 3300
3350  ON II GOTO 3380,3530,3550
3360 PA = 101324 * PCF: GOTO 3380
3370 PA = 14.696 * PCF
3380  INPUT "Non-standard PA?(Y or CR)";A$
3390  IF A$ = "" THEN 3430
3400  IF A$ = "Y" THEN 3420
3410  GOTO 3380
3420  INPUT "PA= ";PA
3430  PRINT : PRINT "PA= ";PA;" ";PU$
3440  INPUT "New PA (Y or CR)";A$
3450  IF A$ = "Y" THEN 3380
3460  IF A$ = "" THEN 3610
3470  GOTO 3440
3480 PCF = 7.5006E - 04:PU$ = "cm Hg": GOTO 3360
3490 PCF = 7.5006E - 03:PU$ = "mm Hg": GOTO 3360
```

```
3500 PCF = 1E - 02:PU$ = "millibar": GOTO 3360
3510 PCF = 1E - 05:PU$ = "bar": GOTO 3360
3520 PCF = 10:PU$ = "dynes/sq cm": GOTO 3360
3530 PCF = 2.036:PU$ = "in Hg": GOTO 3370
3540 UC$ = " Pascal ": GOTO 3560
3550 UC$ = " Psi "
3560  INPUT "Units for PA ";PU$
3570  PRINT "Conversion factor from";UC$;"to ";PU$;: INPUT PCF
3580  IF UN$ = "SI" THEN 3360
3590  GOTO 3370
3600  INPUT PU$,PCF
3610 PA = PA / PCF
3620  IF UN$ = "SI" THEN 3650
3630  IF UN$ = "EU" THEN 3720
3640  GOTO 2990
3650 RK = LS(2):TU$ = "C Deg":VU$ = " cu m/kg":EN$ = " J/kg"
3660 HU$ = " kg water/kg":AU$ = "K Deg"
3670 A = A1:B = B1:C = C1:D = D1:E = E1:F = F1:G = G1:R = R1
3680  FOR II = 1 TO 9:A(II) = AS(II): NEXT
3690  FOR II = 1 TO 20:C(II) = NS(II): NEXT
3700  FOR II = 1 TO 5:TT(II) = LS(II): NEXT
3710  FOR II = 1 TO 2:PT(II) = BS(II): NEXT : GOTO 3800
3720 RK = LE(1):TU$ = "F Deg":VU$ = " cu ft/lb":EN$ = " BTU/lb"
3730 HU$ = " Lb water/lb":AU$ = "R Deg"
3740 A = A2:B = B2:C = C2:D = D2:E = E2:F = F2:G = G2:R = R2
3750  FOR II = 1 TO 9:A(II) = AE(II): NEXT
3760  FOR II = 1 TO 20:C(II) = NE(II): NEXT
3770  FOR II = 1 TO 5:TT(II) = LE(II): NEXT
3780  FOR II = 1 TO 2:PT(II) = BE(II): NEXT : GOTO 3800
3790 PA = PA / PCF
3800 H = 0:HE = 0:PS = 0:PV = 0:PW = 0:RH = 0:TA = 0:TD = 0:TW = 0:VSA =
    0
3810 HK% = 0:HM% = 0
3820  HOME : VTAB 3: PRINT "PROBLEM STATEMENT MENU": PRINT
3830  PRINT "Select a variable pair": PRINT  TAB( 3);"1-TATW": PRINT  TAB(
    3);"2-TATD"
3840  PRINT  TAB( 3)"3-TARH": PRINT  TAB( 3)"4-TWRH": PRINT  TAB( 3);"5-
    TAPV"
3850  PRINT  TAB( 3);"6-TAAH"
3860  INPUT "Enter number: ";ICL$:ICL =  VAL (ICL$): IF ICL < 1 OR ICL >
    6 THEN 3830
3870 A$ =  LEFT$ (T$(ICL),2):B$ =  RIGHT$ (T$(ICL),2)
3880  PRINT "Enter value for ";A$: INPUT " ";X(1)
3890  PRINT "Enter value for ";B$: INPUT " ";X(2)
3900 ICL% = ICL
3910 EM$ = "Solution not programmed for problem posed"
3920  HOME : VTAB 5
3930  PRINT : PRINT "Analysis in progress": PRINT : PRINT
3940  PRINT "Following the CRT display of the"
3950  PRINT "analysis results, depress the"
3960  PRINT "spacebar to continue"
3970  FOR II = 1 TO 6:S$ = V$(II)
3980  GOSUB 5680: IF I = 0 THEN 4000
3990  GOTO 4020
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4000  GOSUB 5710: IF J = 0 THEN 4180
4010  GOTO 4040
4020  ON II GOSUB 4060,4070,4080,4090,4100,4110
4030  GOTO 4180
4040  ON II GOSUB 4120,4130,4140,4150,4160,4170
4050  GOTO 4180
4060 PV = X(1) / PCF: RETURN
4070 RH = X(1): RETURN
4080 TA = X(1) + RK: RETURN
4090 TD = X(1) + RK: RETURN
4100 TW = X(1) + RK: RETURN
4110 H = X(1): RETURN
4120 PV = X(2) / PCF: RETURN
4130 RH = X(2): RETURN
4140 TA = X(2) + RK: RETURN
4150 TD = X(2) + RK: RETURN
4160 TW = X(2) + RK: RETURN
4170 H = X(2): RETURN
4180  NEXT
4190  ON ICL% GOSUB 4200,4300,4400,4510,4640,4790: GOTO 4810
4200  REM  * SUBR TATW *
4210  IF TA < TW THEN 4230
4220  GOTO 4260
4230  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 18: VTAB 4
    : PRINT "TA < TW"
4240  FOR JJ = 1 TO 200: NEXT JJ
4250  NEXT II: FOR KK = 1 TO 700: NEXT : GOTO 3800
4260 T = TA: GOSUB 1540:PS = P:T = TW: GOSUB 1540:PW = P
4270 PV = (2 * PW) - PS: GOSUB 2130: GOSUB 2860: GOSUB 2520
4280 P = PV: GOSUB 1920:TD = T: GOSUB 2620: GOSUB 2690
4290  GOSUB 2960: RETURN
4300  REM  * SUBR TATD *
4310  IF TA < TD THEN 4330
4320  GOTO 4360
4330  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 16: VTAB 4
    : PRINT "TA < TD"
4340  FOR JJ = 1 TO 200: NEXT JJ
4350  NEXT II: FOR II = 1 TO 700: NEXT : GOTO 3800
4360 T = TA: GOSUB 1540:PS = P:T = TD: GOSUB 1540:PV = P
4370 TW = (TA + TD) / 2:T = TW: GOSUB 1540:PW = P
4380  GOSUB 2860: GOSUB 2520: GOSUB 2130
4390  GOSUB 2620: GOSUB 2690: GOSUB 2960: RETURN
4400  REM  * SUBR TARH *
4410  IF RH < 0 THEN EM$ = "R < 0": GOTO 4440
4420  IF RH > 1 THEN EM$ = "RH > 1": GOTO 4440
4430  GOTO 4470
4440  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 18: VTAB 4
    : PRINT EM$
4450  FOR JJ = 1 TO 200: NEXT JJ: NEXT II
4460  FOR II = 1 TO 700: NEXT : GOTO 3800
4470 T = TA: GOSUB 1540:PS = P: GOSUB 2860:P = PV: GOSUB 1920:TD = T
4480 TW = (TA + TD) / 2:T = TW: GOSUB 1540
4490 PW = P: GOSUB 2130: GOSUB 2520: GOSUB 2620
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4500  GOSUB 2690: GOSUB 2960: RETURN
4510  REM  * SUBR TWRH *
4520  IF RH < 0 THEN EM$ = "RH < 0": GOTO 4550
4530  IF RH > 1 THEN EM$ = "RH > 1": GOTO 4550
4540  GOTO 4580
4550  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 18: VTAB 4
    : PRINT EM$
4560  FOR JJ = 1 TO 200: NEXT JJ: NEXT II
4570  FOR II = 1 TO 700: NEXT : GOTO 3800
4580  IF RH = 0 THEN 4600
4590  GOTO 4610
4600 DE% = 6:ID$ = "TWRH": GOTO 1300
4610 T = TW: GOSUB 1540:PW = P:PV = PW / 2:PS = PV / RH:P = PS: GOSUB 19
    20
4620 TA = T: GOSUB 2130: GOSUB 2860:P = PV: GOSUB 1920:TD = T
4630  GOSUB 2520: GOSUB 2620: GOSUB 2690: GOSUB 2960: RETURN
4640  REM  * SUBR TAPV *
4650  IF (PV > PA) THEN 4670
4660  GOTO 4680
4670 EM$ = "PV > PA": GOTO 4700
4680 T = TA: GOSUB 1540:PS = P: IF PS < PV THEN EM$ = "PS < PV"
4690  GOTO 4730
4700  FOR II = 1 TO 5: HOME : FOR JJ = 1 TO 50: NEXT JJ: VTAB 4: HTAB 18
    : PRINT EM$
4710  FOR JJ = 1 TO 200: NEXT JJ: NEXT II
4720  FOR II = 1 TO 700: NEXT : GOTO 3800
4730 P = PV: GOSUB 1920:TD = T: GOSUB 2860
4740  IF ICL% = 6 THEN 4760
4750  GOTO 4770
4760 TW = (TA + TD) / 2:T = TW: GOSUB 1540:PW = P: GOSUB 2130: GOTO 4780

4770  GOSUB 2520:TW = (TA + TD) / 2:T = TW: GOSUB 1540:PW = P: GOSUB 213
    0
4780  GOSUB 2620: GOSUB 2690: GOSUB 2960: RETURN
4790  REM  * SUBR TAAH *
4800  GOSUB 2520: GOSUB 4640: RETURN
4810 TA = TA - RK:TD = TD - RK:TW = TW - RK
4820 PA = PA * PCF:PS = PS * PCF:PV = PV * PCF:PW = PW * PCF
4830  GOSUB 5630
4840 SLOT = 3: GOSUB 5740: GOTO 5010
4850  HOME : PRINT "Maximum loop indices: K(SATP)=";HK%;
4860  PRINT " M(WETBL)=";HM%: PRINT : PRINT
4870  PRINT  TAB( 5);"DATA DISPLAY MENU": PRINT
4880  PRINT  TAB( 4);"CR-Enter new data": PRINT  TAB( 5);"1-Redisplay re
    sults"
4890  PRINT  TAB( 5);"2-Print results": PRINT  TAB( 5);"3-Change units"
4900  PRINT  TAB( 5);"4-Change ambient pressure": PRINT  TAB( 5);"5-Retu
    rn to MAIN MENU"
4910  PRINT  TAB( 5);"6-Exit"
4920  INPUT "Enter number: ";A$: IF A$ = "" THEN 3790
4930 II =  VAL (A$): IF II < 1 OR II > 6 THEN 4870
4940  ON II GOTO 4840,4950,2990,3180,290,5620
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```
4950  IF  PEEK (49305) > 100 THEN 4970
4960  GOTO 4990
4970  FOR II = 1 TO 10: HOME : FOR JJ = 1 TO 50: NEXT JJ: HTAB 18: VTAB
    4: PRINT PR$;IA$
4980  FOR JJ = 1 TO 200: NEXT JJ: NEXT II: GOTO 4850
4990  PRINT : PRINT "Printing psychrometric state results"
5000 SLOT = 1: GOSUB 5740
5010  PRINT  CHR$ (12): REM    PRINTER TOF COMMAND
5020  REM    **
5030  REM     ** STATEMENTS 5080-5190 ROUND VALUES JUST BEFORE PRINTING;
5040  REM    ** THESE STATEMENTS CAN BE DELETED IF ASSOCIATED VARIABLE
5050  REM     ** NAMES ARE CHANGED IN STATEMENTS 5220-5360; THIS WILL
5060  REM    ** REMOVE ROUNDING OF PRINTED VALUES.
5070  REM    **
5080 NUM = PA: GOSUB 5770:PZ = NUM
5090 NUM = TA: GOSUB 5770:TZ = NUM
5100 NUM = PS: GOSUB 5770:P7 = NUM
5110 NUM = TW: GOSUB 5770:TQ = NUM
5120 NUM = PW: GOSUB 5770:P9 = NUM
5130 NUM = TD: GOSUB 5770:T9 = NUM
5140 NUM = PV: GOSUB 5770:P8 = NUM
5150 NUM = RH: GOSUB 5770:R9 = NUM
5160 NUM = H: GOSUB 5770:HZ = NUM
5170 NUM = VSA: GOSUB 5770:VZA = NUM
5180 NUM = HE: GOSUB 5770:HQ = NUM
5190 NUM = Q: GOSUB 5770:QZ = NUM
5200  PRINT L$(1);: POKE 36,40: PRINT "Date: "; MID$ (TIME$,3,8);
5210  PRINT " Time: "; RIGHT$ (TIME$,8): PRINT " "; TAB( 2);L$(3);
5220  PRINT "  ";L$(2);": ";: PRINT PZ;" ";PU$: PRINT " "
5230  PRINT  TAB( 20);L$(5);: POKE 36,42: PRINT L$(6);" ";L$(4);" ";L$(2
    )
5240  PRINT  TAB( 22);"(";TU$;")";: POKE 36,50: PRINT "(";PU$;")"
5250  PRINT  TAB( 2);L$(8);L$(7);D$;: POKE 36,20:
5260  PRINT TZ;D$;: POKE 36,50: PRINT P7
5270  PRINT  TAB( 2);L$(9);L$(7);: PRINT D$;: POKE 36,20:
5280  PRINT TQ;D$;: POKE 36,50: PRINT P9
5290  PRINT  TAB( 2);L$(10);: PRINT D$;: POKE 36,20:
5300  PRINT T9;D$;: POKE 36,50: PRINT P8
5310  PRINT " ": PRINT  TAB( 2);L$(12);L$(11);: POKE 36,27: PRINT R9
5320  PRINT  TAB( 2);L$(13);" ";L$(11);: POKE 36,27: PRINT HZ;HU$;DA$
5330  PRINT " ";: PRINT  LEFT$ (L$(14),9);
5340  PRINT L$(11);: POKE 36,27: PRINT QZ;HU$;WA$
5350  PRINT  TAB( 2);L$(14);: POKE 36,27: PRINT VZA;VU$;DA$
5360  PRINT  TAB( 2);L$(15);: POKE 36,27: PRINT HQ;EN$;DA$
5370  IF SLOT = 3 THEN 5400
5380  FOR II = 1 TO 10: PRINT " ": NEXT
5390 SLOT = 0: GOSUB 5740: GOTO 4850
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```
5400  GET A$: GOTO 4850
5410 SLOT = 3: GOSUB 5740
5420  HOME : PRINT GU$(1): FOR II = 1 TO 1500: NEXT : TEXT : HOME : PRINT
    GU$(2)
5430  FOR II = 3 TO 14: PRINT GU$(II): NEXT
5440  PRINT : PRINT "     Depress spacebar to continue."
5450  GET G$: HOME : PRINT GU$(15)
5460  FOR II = 16 TO 28 STEP 2: PRINT GU$(II);" ";GU$(II + 1): NEXT : PRINT
    "spacebar"
5470  GET G$
5480  HOME : FOR II = 30 TO 38 STEP 2: PRINT GU$(II);" ";GU$(II + 1): NEXT
    : PRINT
5490  PRINT "review (R) guide or(CR)": GET G$
5500 SLOT = 0: GOSUB 5740
5510  IF G$ = "R" THEN 5410
5520  GOTO 460
5530 SLOT = 1: GOSUB 5740
5540  FOR II = 1 TO 10: PRINT : NEXT
5550  PRINT GU$(1): PRINT " ": PRINT GU$(2): PRINT " "
5560  FOR II = 3 TO 14: PRINT ;GU$(II): NEXT : PRINT " "
5570  PRINT GU$(15): PRINT " "
5580  FOR II = 16 TO 38 STEP 2: PRINT GU$(II);" ";GU$(II + 1): NEXT
5590  FOR II = 1 TO 10: PRINT " ": NEXT
5600 SLOT = 0: GOSUB 5740
5610  GOTO 460
5620  END
5630  REM  * SUBR TIME *
5640 SLOT = 4: GOSUB 5740
5650  INPUT ":";TIME$:SLOT = 0: GOSUB 5740
5660  RETURN
5670  REM  * SUBR INSTR **
5680  FOR I = 1 TO  LEN (S$) -  LEN (A$) + 1
5690  IF A$ =  MID$ (S$,I, LEN (A$)) THEN  RETURN
5700  NEXT :I = 0: RETURN
5710  FOR J = 1 TO  LEN (S$) -  LEN (B$) + 1
5720  IF B$ =  MID$ (S$,J, LEN (B$)) THEN  RETURN
5730  NEXT :J = 0: RETURN
5740  REM  * SUBR SELECT PRINT DEVICE **
5750 DD$ =  CHR$ (4): HOME : PRINT DD$"IN#"SLOT: PRINT DD$"PR#"SLOT: RETURN

5760  REM      ** SUBR TO ROUND OFF NUMBERS FOR PRINTING, WORKS FOR NUMB
    RS BETWEEN PLUS OR MINUS (3267699 AND 1.E-10)
5770 ROV = 100.: REM   ** ROUND OFF VALUE, 100 = 3 SIGNIFICANT PLACES.
5780 PO = 1: IF NUM < 0 THEN NUM =  - NUM:PO =  - 1
5790  IF NUM > 32766 THEN RZ = NUM / 100.:I =  - 2: GOTO 5820
5800  IF NUM > ROV THEN RZ = NUM:I = 0: GOTO 5820
5810  FOR I = 1 TO 10:RZ = NUM * (10 ^ I): IF RZ < ROV THEN  NEXT
5820 NU% = RZ + 0.5:NUM = PO * NU% / (10 ^ I): RETURN
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